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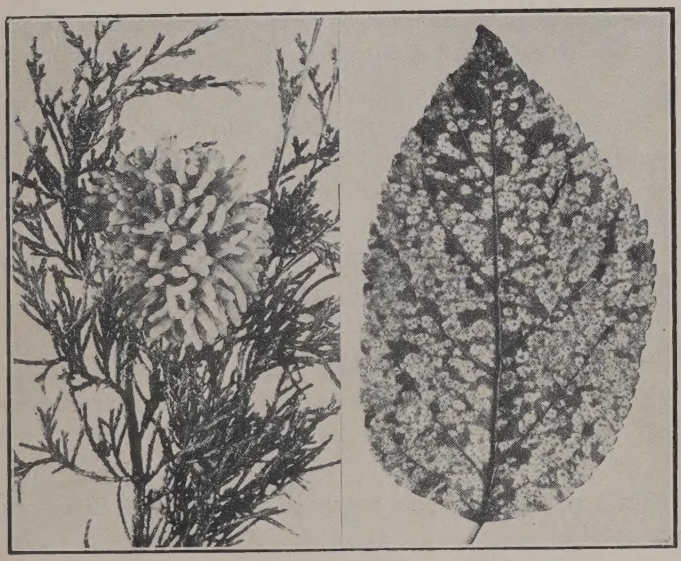
Apple Rust and Its Control

By W. A. McCubbin



Left—Cedar Gall on Which Orange-Colored, Jelly-Like Sporehorns are Mature. Right—Badly Rusted Apple Leaf in Summer.

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SUMMARY

Apple rust, a disease quite common to apples in southeastern Pennsylvania, is due to a fungus which alternates between the apple and the common red cedar.

Rust spots disfigure fruit, cause the tissue around and below the spot to remain green and unripened, make the apples more easily affected by rots, and may result in extensive leaf fall early in the season.

The disease does not spread from cedar to cedar nor from apple to apple; therefore, if one of the "hosts" is absent the rust cannot survive.

Spores of the fungus are carried by the wind in the spring from the cedar to the nearby apple trees.

The rust dies completely on the apple each summer after it has produced a crop of spores to reinfect the surrounding cedars. It does not over-winter on the apple.

Some varieties of apple are resistant to rust while others are not.

Successful control is possible by growing resistant varieties or destroying nearby red cedars. Spraying has not proved satisfactory.

APPLE RUST AND ITS CONTROL

By W. A. McCubbin

Bureau of Plant Industry

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DISTRIBUTION IN PENNSYLVANIA

Apple Rust is a common disease of apples in Pennsylvania but it is usually prevalent enough to be of much importance only in the southern counties, particularly in the southeastern portion of the state below the mountain region. It is apparently more destructive in the states to the south of us, where it becomes at times a serious handicap to the apple industry in certain sections.

WHAT IS APPLE RUST?

Apple Rust is a fungus disease and the causal organism has as a characteristic feature the orange-red or red-brown color from which the popular name for this group of fungi is derived. There are numerous other "rusts" each caused by some particular fungus of this group, attacking various wild and cultivated plants. A very common example of one of these rusts is that found on wheat and oats, which is wide-spread and familiar to nearly every one.

"RUSTS" HAVE ALTERNATE HOST PLANTS

Many of these rust fungi have the peculiar habit of passing a part of their life on each of two separate kinds of plants, and are thus said to have "alternate hosts," since they pass back and forth from one to the other in a very regular fashion. The "wheat rust" just mentioned spends a part of its life on the common barberry, while the "white-pine blister rust" alternates between the white pine and currants or gooseberries. The "apple rust" has this habit likewise, and while it spends the summer on apple trees, it passes

the winter on the common red cedar. Indeed, there is a whole community of these rusts that live over winter on the red cedar and then in summer pass over to various other hosts including the pear, quince, hawthorn and juneberry. One might compare this special group of "red cedar rusts" to city dwellers who live together in the town all winter and then scatter to various seaside or mountain resorts for the summer months, all coming back to their home town again for the next winter.

LIFE HISTORY OF APPLE RUST

General Characteristics. The particular one of these red cedar rusts which has the apple for its alternate host, causes gall-like swellings on the twigs of red cedar trees. Only the red cedar (Juniperus virginiana) is affected by this rust, and not the white cedar, juniper or any other of its relatives in this state. The galls, which are commonly known as "cedar apples," generally are round in shape, of a purplish color, and occur in all sizes up to an inch or more in diameter. In early spring one may find the surface of each gall covered by shallow depressions which have flat pimples in the center (Figs. 1 and 2). The rust fungus has by the irritation of its presence caused the cedar twig to swell, producing this abnormal growth, and in this swollen tissue the fungus remains alive but dormant until growth starts in spring.

How the Rust Grows. About the time the apple leaves begin to unfold, the fungus also starts into growth in the gall and in a few days there is pushed out from each depression a "spore-horn," a projection of jelly-like tissue about as thick as a match and from half an inch to an inch in length (See cover page). These sporehorns are like rich orange jelly when wet but shrink and become dark brown when they dry up. After a rain in spring they are very conspicuous on the trees, and at that time one can readily get the dry spore-horns to swell out by soaking the galls in water for a few minutes.

After a few days each spore-horn produces countless tiny spores (sporidia) on its surface, and these spores, which are carried like dust in the wind, are able to infect the leaves and fruit of the apple, and thus begin the summer life of the rust on that host. Curious as it may seem these spores are quite unable to infect red cedars.

How Distributed. The distance these cedar-gall spores can be carried in the wind is an important question from the standpoint of control. The conclusion has been reached from observations made in numerous localities for many years, that the wind can carry the

spores as much as two miles or even more. On the other hand the vast majority of them will be deposited in the first half or three-fourths of a mile, so that if cedar trees are more than a mile away from an orchard they are likely to be the cause of only a small amount of rust on the apples and then only occasionally. Even a gap of a fourth of a mile, will in most seasons serve to decrease the amount of apple rust to a noticeable degree.

Growth on Apple. On the apple the spore germinates on the surface of the leaf or fruit much as a seed germinates in the soil and the thread-like growth arising from the spore penetrates the tissue and there multiplies to form a slightly raised spot which soon ex-

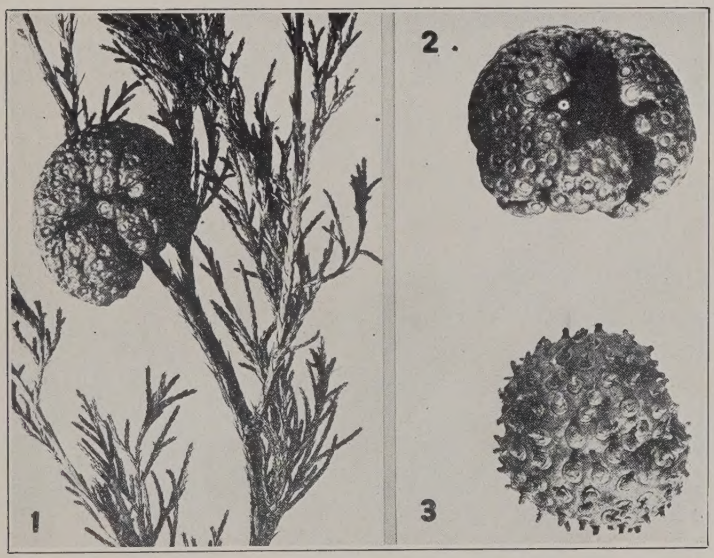

Fig. 1. Apple rust gall on red cedar in fall or winter. Fig. 2. A cedar gall showing characteristic depressions with rounded pimples in early spring. Fig. 3. A cedar gall from which spore-horns are beginning to push out.

hibits the characteristic rust color, i. e., yellow at first, and then deepening to reddish orange. Toward the end of the summer numerous tubes or cups filled with orange spores arise from these spots. If one imagines a tube of thin white paper filled with minute orange-colored grains being pushed up out of the rust spot, it will give a very fair picture of the structure of these rust "cups." If one further imagines the paper splitting downward in strips and curling

outward so as to spill out the enclosed grains, the picture of what happens to the tiny rust cup will be still more complete.

The spots produced on the fruit are irregular and raised, with more or less color. The rust usually is found near the blossom end of the apple, due to its being turned upward in the early stages shortly after blossoming when infection took place. Spore cups also are produced on the fruit, but usually are not so plentiful as on the leaves.

The spores from the rust cups on the apple are quite unable to reinfect that host, so that the rust does not multiply on the apple, as do other fungus diseases such as scab. For this reason all the rust spots on the apple foliage and fruit must be started directly by spores having their origin on nearby red cedars.

Fig. 4. A dangerous situation; a young apple orchard with numerous red cedars close by.

Growth on Cedar. This return infection to the red cedar naturally will take place as soon as the spores ripen in the cups towards the end of summer, but there is no visible effect produced on the red cedar that season. During the next summer, however, the irritation at the point of infection stimulates the cedar tissue which enlarges to form the gall during the growing season. Throughout this process of gall formation, the fungus inside merely grows with the gall but otherwise remains dormant. During the succeeding spring, however, the spore-horns already described are produced,

after which the gall and the fungus within it die out completely. Such galls therefore are a source of danger for one year only.

Thus it will be plain that while the fungus spend the summer on the apple it spends the next winter, the following summer and the succeeding winter on the red cedar. Our fanciful comparison to town and summer home migration is therefore hardly correct, although this comparison in a general way does present the habit of the fungus of living on alternate hosts.

DAMAGE TO THE APPLE

Rust spots on the fruit are quite disfiguring, but the chief damage to the apple results from their effect on the underlying tissue which remains green and unripened for some distance around and below the spot. Rusted apples also are more readily affected by rots.

The greatest damage to apple orchards is to the foliage. It often happens that nearly every leaf in an orchard bears so many rust spots that the active, useful leaf surface is reduced to a fraction of its normal amount, and the whole orchard looks yellow and unhealthy. In such cases the effect on the crop is direct and severe, for these are the leaves that must produce the food materials to build up the fruit to proper size and give it the desirable flavor and texture. In many cases the severity of rust attack may cause extensive leaf fall too early in the season which in itself is a very bad thing for an orchard.

LIMITING FACTORS IN APPLE RUST SPREAD

Since apple-rust fungus does not live over winter on the apple and dies out completely on the red cedar after the spore-horns are developed, it will be evident that the fungus is utterly dependent on the close association of both its hosts in order to continue to propagate itself from year to year. If either host is absent the rust can do nothing, since it must have both to complete its life history.

The rust fungus also is dependent to a large extent on prevailing weather conditions for its perpetuation. If the weather is too dry or too wet during the short period in spring, in which the spore-horns are active, or if the wind is unfavorable little or no apple rust will result in summer, and consequently a lessened reinfection of cedars in the fall, fewer galls will be formed and consequently less rust will be evident the second year after these galls will have matured. In this way the fungus is so absolutely dependent on the whims of the weather that unless the hosts are close to each other and local conditions are very favorable, the amount of apple rust is likely to vary a great deal from year to year.

VARIETAL RESISTANCE TO RUST

Not only is there a great difference in the susceptibility of various apple varities to rust, but this susceptibility appears to vary in different localities, so that lists of susceptible and resistant varieties in different states would not agree. Mr. E. F. Peirce of this Bureau, who has had many years' experience in the apple orchards of the southeastern part of Pennsylvania, makes this statement as to the behavior of the following varieties,—

Susceptible (in order): York, Wealthy, Jonathan, Rome Beauty, Ben Davis, Smokehouse, Fallawater, Grimes Golden.

Resistant: Stayman Winesap, Stark, Stark's Delicious, Baldwin, Maiden Blush, Northern Spy, Yellow Transparent, Paragon, Winesap.

With further reference to the susceptible varieties he states that, "Outside of Smokehouse and Fallawater, in both of which I have noted very serious fruit injury, I have seldom observed rust on the fruit, having seen only one or two York Imperials so marked."

In other states the following varieties have been listed with reference to rust susceptibility:

Very Susceptible: Jonathan, Wealthy, Benoni, Minkler, Rome Beauty, Smith Cider, York Imperial, Red June.

Moderately Susceptible: Ben Davis, Gano, Aikin, N. W. Greening.

Resistant: Grimes, Duchess, Winesap, Stayman Winesap, Yellow Transparent, Northwestern Greening, Arkansas Black, Black Twig, Maiden Blush, Baldwin.

CONTROL OF APPLE RUST

From the foregoing description of the nature of apple rust and the details of its life history, the value of the following methods of control will be apparent:

(1) Planting resistant varieties is the best means of avoiding rust since by this practice one does away at once with any probability of loss and thus eliminates the need for costly control measures later. In planning for an apple orchard in districts subject to rust this point should be given careful consideration.

(2) Planting away from red cedars. Choose a site for the orchard as far distant from red cedars as possible. The farther these alternate hosts can be kept away from the orchard, the less will be the danger of rust.

(3) Spraying of doubtful value. Spraying has been often suggested as a possible method of control since it is so effective with other fungus diseases of the apple. However, spraying for apple rust usually has been a source of disappointment in practice although theoretically it should be successful. The reason lies in the difficulty of applying the spray just at the proper time. It is very hard to predict the exact period when infection will take place since, as pointed out, the rust is so dependent on changing weather conditions. Then too, the apple foliage grows so rapidly during the season of infection that protection only lasts for a few days, and while a number of closely succeeding sprays might be applied to cover the danger period, and would undoubtedly give adequate protection, this would be a very costly procedure. On the other hand a single spray could not be relied on with any degree of certainty.

(4) Removal of surrounding red cedars advised. Orchards already planted to susceptible varieties may be protected from apple rust by removing all red cedars in the vicinity. This is a matter for State action since apple growers are legally powerless to destroy cedars owned by other people on adjacent land. The Pennsylvania Department of Agriculture, through the Bureau of Plant Industry, for several years has carried out a campaign for the protection of commercial orchard districts by the removal of surrounding cedars, and will continue this work in future cases where the size and nature of the endangered orchards justify such action.

How far from an apple orchard should red cedars be removed to give adequate protection from rust? From what has been said previously on the transporting of spores by the wind it may be seen that except where local conditions are of a favorable nature half a mile is the minimum distance that should be considered; and it is far safer to have a mile-wide "cedar-free belt" around the orchard. Even this distance is not an absolute guarantee against all rust, but it will in nearly all cases reduce the apple rust to a negligible amount in most seasons.

(5) Annual removal of galls. Where ornamental red cedars are found to be a source of infection to apples on the same premises and their removal or replacement is not desired, the galls may be cut off and burned each spring before the spore-horns appear.

(6) Destruction of Wild Apples. Wild apple trees growing near red cedars are very likely to aid in perpetuating the rust by plentifully infecting the cedars, and due to the multitude of galls thus formed, nearby orchards may suffer increased rust attacks. Such wild trees should be destroyed without hesitation.